REMARKS

Claims 1-37 are now pending in the application. The Examiner allowed Claims 1-8 subject to correction under 37 C.F.R. 1.75(a). Claims 10, 17, 25, 32, and 33 were canceled without prejudice. Minor amendments have been made to the specification and claims to simply overcome the objections to the specification and rejections of the claims under 35 U.S.C. § 112. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

OBJECTION TO THE DRAWINGS

The Examiner objected to the drawings under 37 C.F.R. 1.83(a) for failing to show every feature of the invention specified in the claims.

Applicant respectfully traverses the objection and submits that the drawings indeed show every feature of the invention specified in the claims. In particular, Applicant respectfully submits that 37 C.F.R. 1.83(a) specifies that "conventional features disclosed in the description and claims, where the detailed illustration is not essential for proper understanding the invention, should be illustrated in a drawing in the form of graphical drawings some that are labeled representation." Applicant respectfully submits that Figures 3-7 and the accompanying description indeed fully describe the fuzzy logic method of tuning a tunable RF device in the method of tuning an RF impedance matching network. In review of the forgoing, Applicant respectfully requests withdraw of the objection.

SUBMISSION OF RIBBONED COPY OF THE SUBJECT PATENT

The Examiner noticed that the original ribboned copy of U.S. patent No. 5,842,154 has not yet been surrendered by the Applicant. Applicant respectfully submits that such a render will occur in due course.

CERTIFICATE OF CORRECTION

The Examiner objected to the specification noting that a certificate of correction was granted to change the original patent and such changes were not properly entered into the reissue application as though part of the original patent. Applicant has included herewith substitute pages having corrected columns 3 and 5 for insertion in the specification. The replacement sheets include the Certificate of Correction changes made in the application without using underlining or brackets.

In view of the submission of the substitute pages, Applicant respectfully requests withdrawal of this rejection.

OBJECTION TO THE CLAIMS

The Examiner objected to Claims 5 and 6 under 37 C.F.R. 1.75(i). Applicant has amended Claims 5 and 6 according to the Examiner's requirement.

The Examiner objected to Claims 1-37 under 37 C.F.R. 1.75(a) for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention.

Applicant has amended several of the claims and has adopted several of the Examiner's suggestions. Regarding the Examiner's objections to claim 9, the last

two lines regarding "the load impedance", Applicant respectfully submits that ample antecedent basis exists for the term load impedance. Applicant can find no reason why every modifier, i.e. "variable", need be included throughout the claim. In the alternative, Applicant respectfully requests the Examiner to cite relevant passages of MPEP that supports such a requirement. Applicant respectfully submits the same arguments with respect to objections raised by the Examiner at Claim 16, lines 9-10 and 13-14.

Accordingly, Applicant respectfully requests withdrawal of the objections to the claims.

REJECTION UNDER 35 U.S.C. § 112

Claims 31-37 stand rejected under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. This rejection is respectfully traversed.

Applicant has amended Claim 31 to eliminate the gap between the steps. Applicant believes this renders the stated grounds for rejection moot.

REJECTION UNDER 35 U.S.C. § 251

Claims 9-37 stand rejected under 35 U.S.C. § 251 as being an improper recapture of broadened claimed subject matter surrendered in the application for the patent upon which the present reissue is based. This rejection is respectfully traversed.

Applicant has amended Claims 9, 16, 24, and 31 in response to the rejections. Applicant believes Claims 9-37 now include the claim limitations identified in the Reasons for Allowance in U.S. application serial no. 08/929,870.

REJECTION UNDER 35 U.S.C. § 103

Claims 31-35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Williams (U.S. Pat. No. 5,889,252) in view of Travaglia (U.S. Pat. No. 5,805,649). This rejection is respectfully traversed.

With respect to Claim 31, Williams does not teach or suggest generating a control signal to adjust the variable impedance of a matching network by applying fuzzy logic rules to a sensed signal to generate a fuzzy output value. Williams uses a transformer in the impedance transformation.

The fuzzy logic approach of the present invention uses fuzzy logic rules to improve orthogonality. When there is more than one error signal, the signals are combined. Therefore, the fuzzy logic approach may use any matching network topology.

Travaglia does not teach or suggest using a fuzzy output value for control. Travaglia at best discusses a controller output based on the sum of the phase error and the fuzzy output. Travaglia also does not teach or suggest adjusting the variable impedance of a matching network to match the impedance of a source and load. Travaglia at best discusses a controller that changes an oscillator frequency until its frequency equals that of a reference frequency to achieve phase lock.

Claims 34-37 depend directly from Claim 31 and are allowable for the same reasons.

CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

Dated: Dec 12, 2001

By: ______________________
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ATTACHMENT FOR CLAIM AMENDMENTS

The following is a marked up version of each amended claim in which underlines indicates insertions and strikethroughs indicate deletions.

1. (AMENDED) Fuzzy logic method of tuning ~~an~~ a radio frequency (RF) matching network of the type having an input at which is applied RF power at a given frequency and at a given impedance, and an output which applies said power to an RF load having a non-constant impedance, said matching network including a phase-magnitude error detector means providing a phase error signal and a magnitude error signal related respectively to impedance phase angle error and impedance magnitude error, and said matching network comprising at least a first variable impedance having a driven element for varying the impedance thereof and a second variable impedance having a driven element for varying the impedance thereof; the method comprising:

supplying said phase and said magnitude error signals to a fuzzy logic controller, wherein each said error signal has a magnitude and direction,

applying each said phase and magnitude error signal to a fuzzy logic inference function based on a number of overlapping fuzzy sets, and where a ~~the~~ value of each said phase and magnitude error signal enjoys membership in one or more fuzzy sets;

applying fuzzy logic rules to said phase and magnitude error signals according to ~~the~~ said one or more fuzzy sets for which said ~~first and second~~ phase and magnitude error signals enjoy membership;

obtaining drive signal values based on said fuzzy logic rules for each of said phase and magnitude error signals;

weighting said drive signal values according to the respective one or more fuzzy sets inference ~~functions~~ for which said phase and magnitude error signals enjoy membership; and

combining said weighted drive signal values to produce an output drive signal for said first variable impedance device driven element.

2. (AMENDED) Fuzzy logic method of tuning an RF matching network according to claim 1, further comprising

obtaining additional drive signal values based on additional fuzzy logic rules for each of said first and second error signals;

weighting said additional drive signal values according to additional respective fuzzy inference functions; and

combining said ~~such~~ weighted additional drive signal values to produce an output drive signal for said second variable impedance device driven element.

3. (AMENDED) Fuzzy logic method of tuning an RF matching network according to claim 2, wherein said fuzzy logic rules and said additional fuzzy logic rules comprise a matrix of NxM drive signal values, where N is the number of fuzzy sets of

said phase error signal and M is the number of fuzzy sets of said magnitude error signal, and each of said drive signal ~~value~~ values and said additional drive signal values corresponds to a given set of said phase error signal and a given set of said magnitude error signal.

4. (AMENDED) Fuzzy logic method of tuning an RF matching network according to claim 1, said number of overlapping fuzzy sets being centered respectively about zero, a medium positive value, a medium negative value, a high positive value, and a high negative value.

5. (AMENDED) A fuzzy logic controller for tuning an RF matching network, wherein said matching network is positioned between a source of applied RF power at a given frequency and at a given impedance, and an RF load having a non-constant impedance, said matching network including a phase-magnitude error detector means providing a phase error signal and a magnitude error signal related respectively to impedance phase angle error and impedance magnitude error, and said matching network comprising at least a first variable impedance device having a driven element for varying the impedance thereof and a second variable impedance device having a driven element for varying the impedance thereof; the fuzzy logic controller comprising

input means receiving values of said phase and magnitude error signals;

means for applying the values of said phase and magnitude error signals to a fuzzy logic inference function based on a number of overlapping fuzzy sets, and

where a ~~the values~~ value of each said phase and magnitude error ~~signals enjoy~~ signal enjoys membership in one or more fuzzy sets;

means for applying fuzzy logic rules to said phase and magnitude error signals according to fuzzy sets for which said error signals enjoy membership;

means for obtaining drive signal values according to said fuzzy logic rules for each ~~set~~ of said fuzzy sets for which said error signals enjoy membership;

means for weighting said drive signal values according to the respective fuzzy inference functions for the values of said phase and magnitude error signals; and

means for combining said weighted drive signal values to produce an output drive signal for said first variable impedance device driven element.

6. (AMENDED) Fuzzy logic controller according to claim 5, further comprising

means for obtaining additional drive signal values based on additional fuzzy logic rules for each of said phase and magnitude error signals;

means for weighting said additional drive signal values according to additional respective fuzzy inference functions; and

means for combining ~~such~~ weighted said additional drive signal values to produce an output drive signal for said second variable impedance device driven element.

7. (AMENDED) Fuzzy logic method of tuning a tunable RF device of the type having an input at which is applied RF power at a given frequency and at a

given impedance, and an output, including an error detector means providing a first error signal and a second error signal, and said tunable RF ~~means~~ device including at least a first variable impedance having a driven element for varying the impedance thereof and a second variable impedance having a driven element for varying the impedance thereof; the method comprising:

supplying said first and said second error signals to a fuzzy logic controller, wherein each of said first and said second error signal has a magnitude and direction,

applying each of said first and said second error signal to a fuzzy logic inference function based on a number of overlapping fuzzy sets, and generating a membership value that corresponds to ~~the~~ an amount of overlapping membership of the error signal value in one or more fuzzy sets;

applying a plurality of fuzzy logic rules to said first and second error signals according to the fuzzy sets for which said first and second error signals enjoy membership;

obtaining a plurality of drive signal values based on said plurality of fuzzy logic rules for each of said first and second error signals;

weighting said drive signal values according to the respective membership values for said first and second error signals; and

combining said weighted drive signal values to produce an output drive signal for said first variable impedance having said first variable impedance device driven element.

8. (AMENDED) Fuzzy logic method of tuning a tunable RF device according to claim 7, further comprising

obtaining a plurality of additional drive signal values based on additional fuzzy logic rules for each of said first and second error signals;

weighting said additional drive signal values according to a plurality of additional respective fuzzy inference functions; and

combining such weighted additional drive signal values to produce an output drive signal for said second variable impedance device driven element.

9. (AMENDED) An electrical network comprising:

a radio frequency (RF) generator for generating an RF signal, the RF generator having a source impedance;

a load receiving the RF signal, the RF signal providing a driving energy to the load, the load having a variable load impedance;

a matching network interposed between the RF generator and the load, the matching network having a variable network impedance, the matching network detecting at least one of ~~a~~ an impedance phase and an impedance magnitude error and generating at least one of a respective ~~corresponding~~ phase error signal and a magnitude error signal, the matching network varying at least one of the impedance phase and the impedance magnitude error in order to vary the network impedance;

a fuzzy inference module receiving the at least one of the restrictive phase and magnitude error signals and defining a membership value that varies in accordance with membership in at least one fuzzy set; and

a controller receiving the at least one respective phase error signal and magnitude error signal, the controller applying the fuzzy logic rules to the at least one of the respective impedance phase error signal and the impedance magnitude error signal according to the fuzzy sets for which said restrictive error signals enjoy membership in order to generate at least one control signal to vary the network impedance, ~~thereby~~ matching the source impedance and the load impedance~~;~~.

11. (AMENDED) The network of claim ~~10~~ 9 wherein the controller further comprises a rules module having a set of rules applied in accordance with the membership value~~s~~, the rules module generating at least one fuzzy output.

12. (AMENDED) The network of claim ~~11~~ 10 wherein the controller further comprises a defuzzification module, the defuzzification module converting the at least one fuzzy output to the at least one control signal.

16. (AMENDED) An electrical network comprising:

a radio frequency (RF) generator for generating an RF signal, the RF generator having a source impedance,

a load receiving the RF signal, the RF signal providing a driving energy to the load, the load having a variable load impedance;

a matching network interposed between the RF generator and the load, the matching network having a variable network impedance, the matching network detecting at least one network parameter and generating at least one sensed signal, the

matching network varying the network impedance in order to match the variable load impedance and the source impedance, wherein the at least one sensed signal comprises at least one of an impedance phase error signal and an impedance magnitude error signal;

a fuzzy inference module receiving the at least one sensed signal and defining a membership value that varies in accordance with membership in at least one fuzzy set; and

a controller receiving the at least one sensed signal, the controller applying fuzzy logic rules to the at least one sensed signal according to the fuzzy sets for which said first and second error signals enjoy membership in order to generate at least one control signal to vary the network impedance, ~~thereby~~ matching the source impedance and the load impedance~~;~~.

18. (AMENDED) The network of claim ~~17~~ 16 wherein the controller further comprises a rules module having a set of rules applied in accordance with the membership value~~s~~, the rules module generating at least one fuzzy output.

19. (AMENDED) The network of claim ~~18~~ 16 wherein the controller further comprises a defuzzification module, the defuzzification module converting the at least one fuzzy output to the at least one control signal.

23. (AMENDED) The network of claim ~~9~~ 16 wherein the load is a RF plasma chamber.

24. (AMENDED) A method of tuning ~~an~~ a radio frequency (RF) impedance matching network having an input which receives RF power and an output which applies the power to a RF load, the matching network having a variable impedance, comprising the steps of:

determining ~~a~~ an impedance phase error and ~~a~~ an impedance magnitude error and generating a corresponding phase error signal and a corresponding magnitude error signal;

applying the phase impedance and magnitude impedance error signals to a fuzzy logic inference function, the phase and magnitude error signals each having at least one respective membership value in at least one fuzzy set; and

applying fuzzy logic rules to the impedance phase and impedance magnitude error signals according to the fuzzy sets for which said error signals enjoy membership to generate fuzzy output signals based upon the phase and the magnitude error signals and generating a control signal to adjust the variable impedance of the matching network~~;~~.

26. (AMENDED) The method of claim ~~25~~ 24 wherein the step of applying fuzzy logic further comprises applying logic rules to the at least one respective membership value to generate at least one respective fuzzy output value.

27. (AMENDED) The method of claim ~~26~~ 24 wherein the step of applying logic rules further comprises the step of weighting the at least one respective fuzzy output value according to the at least one respective membership value.

28. (AMENDED) The method of claim 27 wherein the step of applying ~~fuzzy~~ logic rules further comprises the step of combining said weighted at least one respective fuzzy output values to produce the control signal.

29. (AMENDED) The method of claim ~~26~~ 24, wherein the ~~fuzzy~~ logic rules comprise a matrix of NxM fuzzy output values, where N is the number of fuzzy sets of a first sensed signal and M is the number of fuzzy sets of a second sensed signal, and each fuzzy output value corresponds to a predetermined set of the first sensed signal and a predetermined set of the second sensed signal.

30. (AMENDED) The method of claim ~~25~~ 24 wherein the at least one fuzzy set comprises a plurality of fuzzy sets centered respectively about zero, a medium positive value, a medium negative value, a high positive value, and a high negative value.

31. (AMENDED) A method of tuning ~~an~~ a radio frequency (RF) impedance matching network having an input which receives RF power and an output which applies the power to a RF load, the matching network having a variable impedance, comprising the steps of:

determining a network parameter and generating a corresponding sensed signal that varies in accordance with the network parameter;

<u>applying the corresponding sensed signal to a fuzzy logic inference function, the corresponding sensed signal having at least one respective membership value in at least one fuzzy set; and</u>

applying fuzzy logic <u>rules</u> to the <u>corresponding</u> sensed signal <u>according to fuzzy sets for which said error signal enjoys membership</u>;

<u>generating</u> fuzzy output signals based upon the <u>corresponding</u> sensed signal; <u>and</u>

generating a control signal to adjust the variable impedance of the matching network based upon the fuzzy output signals.

33. (AMENDED) The method of claim <u>31</u> ~~32~~ wherein the step of applying fuzzy logic further comprises applying logic rules to the at least one respective membership value to generate at least one respective fuzzy output value.

34. (AMENDED) The method of claim ~~33~~ <u>31</u> wherein the step of applying logic rules further comprises the step of weighting the at least one respective fuzzy output value according to the at least one respective membership value.

35. (AMENDED) The method of claim 34 wherein the step of applying ~~fuzzy~~ logic rules further comprises the step of combining said weighted at least one respective fuzzy output value<u>s</u> to produce the control signal.

36. (AMENDED) The method of claim ~~33~~ 31, wherein the ~~fuzzy~~ logic rules comprise a matrix of NxM fuzzy output values, where N is the number of fuzzy sets of the corresponding sensed signal and M is the number of fuzzy sets of a second sensed signal, and each fuzzy output value corresponds to a predetermined set of the ~~first~~ sensed signal and a predetermined set of the second sensed signal.

37. (AMENDED) The method of claim ~~32~~ 31 wherein the at least one fuzzy set comprises a plurality of fuzzy sets centered respectively about zero, a medium positive value, a medium negative value, a high positive value, and a high negative value.